

## Teachers' Strategies in Pancasila Education to Cultivate Critical Thinking Skills among Vocational High School Students in The AI-Driven World

Elly Sukma Sari<sup>1</sup>, Patmisari Patmisari<sup>2</sup>

<sup>1,2</sup> Faculty of Education Sciences, Universitas Muhammadiyah Surakarta, Surakarta, Indonesia

Email: [pat179@ums.ac.id](mailto:pat179@ums.ac.id)

### Abstract

**Purpose:** This study aims to explain how Pancasila Education teachers develop students' critical thinking skills at SMK Negeri 2 Surakarta in facing an AI-driven world, focusing on strategies for designing, implementing, and evaluating *Problem-Based Learning* and group discussions to foster logical, analytical, and reflective thinking without reliance on AI.

**Methodology:** This research employs a descriptive qualitative approach with a case study design. The participants include the Curriculum Team, Pancasila Education teachers, and students from Construction and Housing Engineering, Geomatics Engineering, Electronics Engineering, Building Modeling and Information Design, and Metal Welding and Fabrication programs. Data were collected through classroom observations, in-depth interviews, and document analysis of lesson plans, teaching materials, and assessment instruments. Data were analyzed using an interactive model involving data reduction, data display, and conclusion drawing, with validity ensured through triangulation and member checking.

**Results:** Research shows that implementing *Problem-Based Learning* and group discussions is efficacious in improving students' critical thinking skills. Teachers act as facilitators who encourage students to analyze information, evaluate various perspectives, and draw rational conclusions. The use of AI is employed as a tool to assist in information searching, but it is limited to prevent dependency and to continue stimulating students' independent thinking processes.

**Applications/Originality/Value:** This study highlights the strategic role of Pancasila Education teachers in strengthening students' critical thinking in an AI-driven world. The integration of active learning strategies with controlled AI use helps prevent technological dependence and prepares students to make rational decisions in an AI-based workforce.

### Introduction Section

21st-century education requires students to master the 4Cs skills: *critical thinking, communication, creativity, and collaboration*, with critical thinking as the core ability to analyze information, evaluate arguments, and make logical decisions (Subro & Fawaid, 2025). In this context, Pancasila Education not only functions as an ideological subject but also as a means to strengthen critical reasoning through case analysis, problem-solving, and ethical assessment of national values, as proposed by Aini (2024). For vocational high school students, critical thinking skills become an essential foundation in facing the demands of the working world (Latifah et al., 2025).

However, the implementation of Pancasila Education at vocational high schools still faces various obstacles. Narimo et al (2025) explains that learning focused on memorization limits the space for discussion and critical argumentation of findings. Wayudi et al (2020) shows that a teacher-centered learning approach tends to make students passive and less prepared to think at higher levels. This condition is reinforced by Rohmah et al (2023) which emphasizes that the limited problem-solving activities have prevented Pancasila Education from being optimal in developing critical thinking and reflective civic awareness.

The development of AI opens up opportunities to strengthen critical learning through adaptive learning experiences. However, Saputra et al (2024) highlight digital literacy among vocational high school teachers as the main obstacle to AI integration. Additionally, Widiarti (2024) emphasizes the importance of ethical considerations and highlights the limitations of digital literacy among vocational high school teachers as the main obstacle to AI integration. Additionally, data security in the utilization of AI in education. From the students' side, Barus et al (2023) show that a low understanding of the benefits and risks of AI makes this technology not fully supportive of the development of critical thinking. The low critical thinking ability of vocational high school students is influenced by passive attitudes, low self-confidence, and a lack of high-level thinking practice, which causes difficulties in analyzing questions, connecting concepts, and constructing arguments (Melindah et al., 2024). External factors such as low motivation to learn, monotonous teaching methods, and a lack of analytical media also worsen the situation, thereby affecting students' readiness to enter the workforce, which demands problem-solving skills and decision-making grounded in reasoning (Mulyatiningsih, 2016). Therefore, learning needs to be designed to encourage exploration, dialogue, and independent analysis through student-oriented strategies, such

as the MURDER reflective model that trains critical thinking skills through real-world problem solving (Sari, 2014), as well as an Open-Ended approach that allows students to explore solutions, analyze assumptions, and draw logical conclusions (Putri, 2013). This phenomenon is observed at SMK Negeri 2 Surakarta, where Pancasila Education teachers need to implement learning strategies that consciously develop students' critical thinking skills in the context of a world based on artificial intelligence, considering the challenges of digital literacy, the potential dependence on AI, and the differences in thinking abilities across majors.

Various studies on Pancasila Learning generally highlight discussion models, PBL, and audiovisual media, but most focus on motivation to learn and character at the junior high and high school levels (Widayati & Patmisari, 2024). Research on teachers' strategies for developing critical thinking in vocational high schools through technology and artificial intelligence remains limited, even though vocational students have diverse vocational needs and thinking abilities, requiring a more contextual learning approach (Sukisno et al., 2020). Research on Pancasila Education in Vocational High Schools (SMK) remains limited in examining the complexity of the vocational environment, including variations in thinking abilities across majors, digital literacy disparities, and students' tendencies to rely on artificial intelligence. This condition is reinforced by students' low reading interest and the challenges teachers face in managing technology-based learning, resulting in less-than-optimal effectiveness of teaching strategies. Therefore, a study is needed to specifically explore how Pancasila Education teachers design and implement teaching strategies to develop SMK students' critical thinking skills in an AI-driven world. This research focuses on teachers' strategies for fostering critical thinking among SMK students to make learning more adaptable to the demands of the workforce and the dynamics of an AI-driven world.

In line with this condition, this study aims to expand understanding of the strategies Pancasila Education teachers use to foster students' critical thinking skills in vocational high schools during the era of AI development. Although research on digital literacy and AI use in schools is extensive, very few studies directly address how Pancasila Education teachers develop students' critical thinking abilities through learning strategies aligned with AI advancements. Additionally, the dynamics of vocational education, including differences in students' abilities and teachers' readiness, have not been the primary focus of many studies, despite their significant impact on learning outcomes. Therefore, this research seeks to understand teachers' strategies for enhancing critical thinking skills in the AI era, making Pancasila Education more adaptable to workforce demands and ongoing technological developments.

## Literature Review

Model *Problem-Based Learning* is one of the dominant teaching approaches in strengthening the critical thinking skills of vocational high school students. Ariyanto et al (2020) explains that PBL provides students with space to identify problems and formulate solutions grounded in rational arguments. The findings are in line with Kurniawati (2022); Maharani (2023) which shows that students' active involvement in the *Problem-Based Learning* stages contributes to improved data analysis skills and logical decision-making. However, most studies still emphasize the overall effectiveness of *Problem-Based Learning* without examining how teachers adapt the PBL stages to the heterogeneity of vocational high school students. This indicates a research gap regarding teachers' strategies in optimizing the implementation of PBL to align with vocational learning needs. In addition to *Problem-Based Learning*, cooperative learning also helps improve students' critical thinking skills. Pater (2019) emphasizes that the Group Investigation model not only develops argumentative skills but also shapes democratic attitudes through the discussion process. Findings Dika et al (2024) show that group discussions enrich students' reasoning quality through the exchange of diverse perspectives. However, these studies have not yet thoroughly examined the teacher's role in managing group dynamics, addressing participation imbalances, and designing provocative questions that encourage higher-order thinking. Therefore, although cooperative learning has proven effective, the pedagogical mechanisms teachers use to guide students' critical thinking have not been extensively analyzed.

The dimensions of digital literacy and 21st-century character are also considered important in the development of critical thinking among vocational high school students. Martini (2022) emphasizes that vocational education requires strengthening digital literacy and character to shape students who are critical and adaptive, in line with the perspective Sari & Mahatmaharti (2023) which highlights the importance of the ability to connect information and draw meaningful conclusions. However, research that integrates digital literacy, Pancasila character, and higher-order thinking strategies within a single pedagogical framework remains limited. Studies on artificial intelligence show that AI has the potential to support the development of critical thinking through personalized learning and adaptive feedback, as expressed by (Ramadhanti 2023; Nurlaili & Utami 2023). Mukhlis et al (2025) added that the integration of AI in project-based learning can strengthen the Pancasila Student Profile. However, most of these studies have not highlighted ethical, privacy, and algorithmic bias aspects, even though these issues are relevant in Pancasila Learning, which is based on moral values. Therefore, this research considers it important for Pancasila Education teachers to develop strategies to design, guide, and control the pedagogical use of AI to foster students' critical thinking skills, reflective, and responsible, in the era of AI-based learning.

These limitations indicate that there is still limited research that comprehensively examines how Pancasila Education teachers in vocational high schools design, facilitate, and evaluate the critical thinking process within an educational ecosystem influenced by AI technology. Therefore, this study uses a critical thinking framework Ennis (2000),

those who interpret critical thinking as a process of logical and reflective thinking to determine what should be believed or done, as well as indicators of critical thinking Facione & Facione (1996) interpretation, analysis, evaluation, inference, explanation, and self-regulation as an analytical lens. This framework is used to assess the extent to which the Pancasila Education teacher's strategies at vocational high schools can foster students' critical thinking skills in the era of artificial intelligence.

## Metode

This research uses a qualitative descriptive design to provide an in-depth description of the strategies used by Pancasila Education teachers in developing critical thinking skills among vocational high school students in the era of artificial intelligence. This design was chosen because the study focuses on exploring the processes, meanings, and contexts of learning naturally, rather than testing hypotheses, in line with the perspective Sugiyono (2013) The qualitative research emphasizes understanding phenomena as they are. Additionally, the study employs a case study approach, which is most appropriate when the researcher aims to answer how and why questions in real-life situations, allowing the researcher to understand teachers' strategies in context and in depth. The research was conducted from September to November 2025, coinciding with odd-semester learning activities, allowing direct observations of the learning process in the natural classroom setting.

The research participants consisted of Pancasila Education teachers, the Curriculum Team, and students from five majors at SMK Negeri 2 Surakarta, namely Construction and Housing Engineering, Geomatics Engineering, Electronics Engineering, Building Modeling and Information Design, and Welding and Metal Fabrication Engineering. The focus of the research was on teachers' strategies in fostering critical thinking through the implementation of *Problem-Based Learning* and group discussions. Data collection was conducted through classroom observations, semi-structured interviews, and documentation, including lesson plans, activity photos, and student work products. Data analysis was carried out using an interactive model, which included stages of data reduction, data presentation, and conclusion drawing, repeated iteratively until valid findings were obtained. The validity of the data was maintained through source and technique triangulation and member checks with participants. Ethical aspects of the research were implemented through informed consent, anonymity, confidentiality of information, and fair treatment of all participants, ensuring that the research process adhered to scientific standards and respected their rights (Hansen, 2023).

## Results and Discussion

### Description of results

#### Description of Developing Critical Thinking Skills of Vocational High School Students in the Era of AI

The development of critical thinking skills is achieved by limiting the use of AI as an instant solution, strengthening digital literacy, and promoting discussion-based learning. Students are guided to find credible sources, interpret information, and formulate their own arguments, positioning AI as a tool to assist rather than replace the thinking process. The Curriculum Team of SMK Negeri 2 Surakarta stated:

*"Sekolah terus beradaptasi dengan kemajuan teknologi melalui pemanfaatan Gemini sebagai sarana pendukung guru dalam penyusunan perangkat pembelajaran. Namun, pihak sekolah menegaskan bahwa teknologi hanya berfungsi sebagai alat bantu untuk meningkatkan efektivitas proses belajar, bukan sebagai pengganti peran berpikir kritis, kreativitas, dan interaksi manusiawi antara guru dan siswa"* (Schools continue to adapt to technological advancements by using Gemini as a support tool for teachers in developing learning materials. However, the school stresses that technology is only an aid to improve the effectiveness of the learning process, not a replacement for critical thinking, creativity, and human interaction between teachers and students). (Interview, November 5, 2025).

The Pancasila Education Guru emphasizes:

*"Saya tidak mengizinkan siswa menggunakan AI mencari jawaban karena hal tersebut membuat mereka terbiasa dengan cara yang instan. Saya lebih mendorong siswa untuk berusaha secara mandiri, misalnya dengan mencari informasi dari artikel atau sumber internet yang kredibel, kemudian menganalisis dan menafsirkan informasi tersebut. Dengan demikian, jawaban yang mereka hasilkan benar-benar merupakan hasil pemikiran sendiri dan dapat dipertanggungjawabkan secara akademis"* (I do not allow students to use AI to find answers because it makes them accustomed to instant methods. I prefer to encourage students to try independently, for example by searching for information from credible articles or internet sources, then analyzing and interpreting that information. In this way, the answers they produce are truly their own thoughts and can be academically justified). (Interview, November 6, 2025).

Supported by expressions from Geomatics Engineering students:

*"Menurut saya, di era teknologi saat ini banyak pelajar menggunakan AI tanpa terlebih dahulu mencari sumber yang jelas. Dalam pembelajaran, guru mendorong kami mencari referensi dari artikel atau jurnal kredibel dan mendiskusikannya dalam kelompok agar kami terbiasa menganalisis dan bertukar argumen. AI hanya digunakan sebagai pelengkap karena penggunaan yang terlalu sering dapat membuat siswa kurang terbiasa berpikir kritis"* (In

my opinion, in today's technological era, many students use AI without first seeking clear sources. In learning, teachers encourage us to find references from credible articles or journals and discuss them in groups so that we become accustomed to analyzing and exchanging arguments. AI is only used as a supplement because overusing it can make students less accustomed to thinking critically). (Interview, November 12, 2025).

Construction and Housing Engineering students expressed:

*"Nah, justru karena perkembangan teknologi Guru lebih sering menerapkan diskusi kelompok agar saya aktif bekerja sama dan berkomunikasi. Tugas mandiri cenderung mendorong penggunaan AI secara instan tanpa pemahaman, sedangkan diskusi menuntut saya membaca dan memahami materi terlebih dahulu, sehingga meningkatkan literasi membaca. Sebagai siswa SMK generasi Z di era digital, kami menyadari AI memiliki dampak positif dan negatif, tergantung cara penggunaannya mbak"* (No, actually because of technological development, teachers more often implement group discussions so I actively work together and communicate. Independent assignments tend to encourage the use of AI instantly without understanding, whereas discussions require me to read and understand the material first, thereby improving reading literacy. As a Generation Z vocational high school student in the digital era, we realize that AI has both positive and negative impacts, depending on how it is used, miss). (Interview, November 7, 2025).



**Figure 1.** Students Discussing in a Group.

The results of the observation are supported by interview findings that show similar patterns and conditions in the field; accordingly, students of Construction and Housing Engineering stated that:

*"Emm kalau belajar secara berkelompok itu menurut saya lebih efektif, bisa saling berdiskusi untuk memahami dan menganalisis informasi yang kami dapat dari internet maupun dari buku. Setelah itu, kami menyusun argumen yang bisa dipertanggungjawabkan saat presentasi atau diskusi kelas. Dari situ, kami jadi terbiasa berpikir kritis dan juga belajar menghargai pendapat teman-teman lain, karena setiap orang punya cara pandang yang berbeda"* (Um, I think studying in groups is more effective. We can discuss with each other to understand and analyze the information we get from the internet or from books. After that, we prepare arguments that can be justified during presentations or class discussions. From there, we become accustomed to thinking critically and also learning to respect other friends' opinions because everyone has different perspectives). (Interview, November 7, 2025).

The Metal Welding and Fabrication Engineering students expressed their enjoyment of learning using technology:

*"Kalau saya sendiri, Mbak, masih kadang menggunakan AI, tapi hanya sebentar...hehe. Saat diskusi kelompok, guru melarang penggunaan AI agar siswa benar-benar berdiskusi, menganalisis, dan menyusun argumen secara mandiri. AI hanya diperbolehkan di luar diskusi sebagai pendukung pencarian referensi yang relevan, bukan sebagai sumber jawaban"* (As for me, miss, I still sometimes use AI, but only for a short while... hehe. During group discussions, teachers prohibit the use of AI so that students can truly discuss, analyze, and formulate arguments independently. AI is only allowed outside of discussions as a support for searching relevant references, not as a source of answers.). (Interview, November 12, 2025).

The interview results indicate that group discussions are effective in developing critical thinking skills among vocational high school students in the AI era. Through discussions, students are encouraged to read, understand, and analyze material before presenting arguments, so they do not rely on instant AI responses. Discussions also train students to formulate rational arguments, respect differing opinions, and collaborate in problem-solving. Teachers choose this strategy to minimize dependence on technology and strengthen reading literacy, while AI is used only sparingly to clarify understanding, not to replace students' thinking processes.

### **Description of Obstacles in Developing Critical Thinking Skills of Vocational High School Students in the AI Era**

The use of AI, low reading interest, and differences in characteristics among majors obstruct the development of critical thinking at SMK Negeri 2 Surakarta. The Curriculum Team of SMK Negeri 2 Surakarta stated:

*"Tak dapat dipungkiri, Mbak, AI memang sangat membantu guru dan siswa dalam proses pembelajaran. Namun, di sisi lain, kami juga melihat dampak negatifnya anak-anak cenderung menjadi malas berpikir sendiri, dan minat baca mereka mulai menurun. Oleh karena itu, kami mencoba menyeimbangkannya dengan menerapkan pembelajaran berbasis proyek. Melalui kegiatan proyek, siswa didorong untuk menganalisis, menemukan solusi, dan berpikir kritis terhadap permasalahan di dunia nyata, sehingga mereka tidak hanya bergantung pada hasil instan dari teknologi"* (It cannot be denied, Miss, that AI is indeed very helpful for teachers and students in the learning process. However, on the other hand, we also see its negative impacts, such as children tending to become lazy in thinking for themselves, and their reading interest starting to decline. Therefore, we try to balance it by implementing project-based learning. Through project activities, students are encouraged to analyze, find solutions, and think critically about real-world problems, so they do not solely rely on instant results from technology). (Interview, November 5, 2025).

The Pancasila Education Guru states:

*"Setiap jurusan memiliki karakteristik siswa berbeda, sehingga strategi pembelajaran berbeda. Siswa jurusan Teknik Konstruksi dan Perumahan, Teknik Geomatika, serta Teknik Elektronika cenderung lebih aktif dan cepat memahami pembelajaran berbasis diskusi kelompok. Sementara, siswa jurusan Pemodelan dan Perancangan Informasi Bangunan serta Teknik Pengelasan dan Fabrikasi Logam membutuhkan pendekatan yang lebih bertahap dan kontekstual dengan contoh yang dekat dengan praktik kejuruan. Perbedaan ini menjadi tantangan guru di era AI, strategi pembelajaran disesuaikan agar teknologi berfungsi sebagai alat bantu mendorong, bukan menggantikan, proses berpikir kritis"* (Each major has students with different characteristics, so the learning strategies also differ. Students in the Construction and Housing Engineering, Geomatics Engineering, and Electronics Engineering majors tend to be more active and quickly grasp discussion-based learning. Meanwhile, students in Building Information Modeling and Design, as well as Welding and Metal Fabrication Engineering, require a more gradual and contextual approach with examples close to vocational practices. These differences pose a challenge for teachers in the AI era teaching strategies should be adjusted so that technology functions as a tool to support, not replace, the critical thinking process). (Interview, November 6, 2025).

In addition, the Metal Welding and Fabrication Engineering students stated that:

*"Saya, Mbak, kalau ingin tahu sesuatu biasanya mencari informasi langsung lewat ponsel, baik dari media sosial seperti Facebook dan TikTok maupun dari AI karena cepat dan praktis. Saya lebih suka belajar lewat video daripada membaca buku. Namun, karena terlalu sering menggunakan AI, saya jadi merasa malas berpikir sendiri. Menurut saya, penggunaan AI yang berlebihan menjadi salah satu hambatan dalam melatih kemampuan berpikir kritis siswa"* (I, Mbak, usually look for information directly through my phone when I want to know something, whether from social media like Facebook and TikTok or from AI because it's quick and convenient. I prefer learning through videos rather than reading books. However, because I use AI too often, I start to feel lazy about thinking for myself. In my opinion, excessive use of AI becomes one of the obstacles in developing students' critical thinking skills). (Interview, November 12, 2025).

Geomatic Engineering students also shared their opinions by stating that:

*"Saya sering melihat teman-teman menyalin jawaban dari AI tanpa membaca atau menganalisis kembali kebenarannya. Dalam diskusi kelompok, biasanya hanya sebagian siswa yang aktif, sementara lainnya cenderung pasif dan mengikuti hasil kerja teman. Saat berdiskusi, ada yang mengandalkan AI dan ada yang mencari dari artikel atau Google, sehingga tantangan utamanya bagaimana kami benar-benar mengembangkan kemampuan berpikir kritis kami"* (I often see friends copying answers from AI without reading or reanalyzing their accuracy. In group discussions, usually only some students are active, while others tend to be passive and just follow their friends' work. During discussions, some rely on AI, while others search from articles or Google, so the main challenge is how we can truly develop our critical thinking skills). (Interview, November 12, 2025).

A similar opinion also came from students of Construction and Housing Engineering, who stated that:

*"Pembelajaran Pancasila cukup menyenangkan karena guru bersikap lembut dan mudah diajak belajar. Metode yang digunakan biasanya ceramah dan diskusi kelompok, yang memiliki dampak positif dan negatif. Kadang materi sulit dipahami karena suasana belajar dan perbedaan gaya belajar siswa. Dalam diskusi kelompok, tidak semua anggota berkontribusi secara aktif, sehingga saya terkadang lebih nyaman belajar mandiri"* (Learning Pancasila is quite enjoyable because the teacher is gentle and easy to learn from. The methods used are usually lectures and group discussions, which have both positive and negative impacts. Sometimes the material is difficult to understand due to the learning atmosphere and students' different learning styles. In group discussions, not all members contribute actively, so I sometimes feel more comfortable studying alone). (Interview, November 7, 2025).

As conveyed by the Electronics Engineering Student:

*"Ya, Mbak, selama proses pembelajaran kami tidak diperbolehkan menggunakan ponsel, kecuali guru mengizinkan keperluan mencari materi pembelajaran. Guru menekankan agar kami mencari sumber dari internet atau artikel yang kredibel dan dapat dipertanggung jawabkan. Tujuannya agar kami belajar memilah informasi yang akurat dan tidak asal ambil dari sumber yang tidak jelas. Namun, saya dan teman-teman juga menggunakan AI untuk membantu menyusun argumen, ketika kami kesulitan menyusun kalimat yang tepat. Jadi, kami menggunakan AI bukan untuk mencari jawaban instan, melainkan sebagai alat untuk membantu menyusun bahasa agar ide kami dapat tersampaikan dengan jelas"* (Yes, Miss, during the learning process we are not allowed to use our phones, unless the

teacher permits it for the purpose of searching for learning materials. The teacher emphasizes that we should find sources from the internet or credible articles that can be justified. The goal is for us to learn how to filter accurate information and not just take it from unclear sources. However, my friends and I also use AI to help organize arguments when we have difficulty formulating the right sentences. So, we use AI not to find instant answers, but as a tool to help structure our language so that our ideas can be conveyed clearly). (Interview, November 7, 2025).

The interview results show that restrictions on AI and phone use in learning help students sort credible sources of information, but difficulties in constructing arguments and limited vocabulary still pose obstacles. This condition causes some students to continue relying on AI to tidy up their language, which could potentially hinder independent critical thinking if not managed with appropriate pedagogical strategies.

### **Description of Critical Thinking Strengthening Solution as a Learning Strategy for Vocational High School Students in the AI Era**

The enhancement of students' critical thinking skills at SMK Negeri 2 Surakarta is achieved through project-based learning, fostering reading literacy, and guiding the responsible use of AI to prevent dependence on instant answers. Project-based learning encourages students to solve real-world problems in accordance with their expertise, as emphasized by the Curriculum Team of SMK Negeri 2 Surakarta.

*"Penggunaan AI ada plus dan minusnya, Mbak. Penggunaan AI memiliki kelebihan dan kekurangan. Di satu sisi membantu pembelajaran, tetapi di sisi lain dapat membuat siswa malas berpikir dan menurunkan literasi membaca. Untuk mengatasinya, guru menerapkan pembelajaran berbasis proyek yang menuntut keterlibatan langsung siswa. Misalnya pada jurusan Teknik Konstruksi dan Perumahan, siswa harus turun ke lapangan untuk membuat batako, sehingga mereka belajar menganalisis, memecahkan masalah nyata, dan berpikir kritis sesuatu yang tidak dapat digantikan oleh AI"* (The use of AI has its pros and cons, ma'am. Using AI has advantages and disadvantages. On one hand, it helps with learning, but on the other hand, it can make students lazy to think and decrease reading literacy. To address this, teachers implement project-based learning that requires students to be directly involved. For example, in the Construction and Housing Engineering department, students must go into the field to make concrete blocks, so they learn to analyze, solve real problems, and think critically things that cannot be replaced by AI). (Interview, November 5, 2025).

As expressed in an interview by the Pancasila Education teacher:

*"Saya akan terus berusaha mengembangkan minat baca siswa dan mendorong mereka agar tidak kecanduan menggunakan ponsel maupun AI. Dalam pembelajaran, saya menerapkan aturan yang harus dipatuhi siswa, misalnya penggunaan ponsel hanya diperbolehkan jika mendapat izin dari guru pada saat jam pelajaran. Selain itu, saya juga berupaya memotivasi siswa agar terus berkembang menjadi lebih baik melalui kegiatan pembelajaran kelompok. Melalui kegiatan ini, saya berharap siswa dapat bekerja sama dengan baik, memiliki etika yang baik, serta menunjukkan sikap saling menghargai"* (I will continue to work on developing students' interest in reading and encourage them not to become addicted to phones or AI. In my teaching, I set rules that students must follow, such as only using phones with the teacher's permission during class. I also try to motivate students to keep improving through group learning activities. Through these activities, I hope students can collaborate well, show good manners, and demonstrate mutual respect). (Interview, November 6, 2025).

A Building Information Modeling and Design student stated:

*"Iya, mbk saya langsung menerapkan teori yang diajarkan di kelas ke praktik kerja. Saat ini saya sedang magang di sebuah perusahaan konstruksi perumahan. Di sana, saya belajar memecahkan masalah dunia nyata yang membutuhkan keterampilan berpikir kritis, seperti menganalisis akar permasalahan, menemukan solusi alternatif, dan membuat keputusan yang tepat dalam kondisi terbatas. Pengalaman ini memungkinkan saya tidak hanya memahami teori secara konseptual tetapi juga menilai relevansinya dalam situasi dunia nyata. Selama magang, kami juga berpartisipasi dalam sesi pembelajaran intensif, sehingga keterampilan berpikir kritis kami terus diasah baik melalui praktik lapangan maupun pembelajaran akademis"* (Yes, miss, I immediately applied the theories I learned in class to practical work. Currently, I am interning at a residential construction company, where I learn to solve real-world problems that require critical thinking skills, such as analyzing root causes, finding alternative solutions, and making the right decisions under limited conditions. This experience helps me not only understand the theories conceptually but also evaluate their relevance in real-world situations. During the internship, we also participate in intensive learning sessions, so our critical thinking skills are continually sharpened through both field practice and academics learning). (Interview, November 8, 2025).

Supported by students of Construction and Housing Engineering:

*"Dalam beberapa situasi, terutama saat diskusi kelompok pada materi Pancasila tentang nilai dan norma hukum, AI digunakan secara terbatas untuk melengkapi sumber dari buku dan internet. Informasi tersebut kemudian dianalisis dan didiskusikan bersama serta dikaitkan dengan konteks dunia kerja. Jika siswa masih mengalami kesulitan dalam memahami atau menilai informasi, guru tetap menjadi rujukan utama melalui bimbingan dan penguatan analisis"*

(In some situations, especially during group discussions on Pancasila material about legal values and norms, AI is used in a limited way to supplement sources from books and the internet. The information is then analyzed and discussed together and connected to the context of the workplace. If students still have difficulty understanding or evaluating the information, the teacher remains the main reference through guidance and reinforcement of analysis). (Interview, November 7, 2025)

Strengthened by the expression of an Electronics Engineering student who stated that:

*"Saya tidak hanya mencari jawaban di internet, buku, artikel, tapi saya telaah dahulu. Saya mencoba memahami konteks kemudian menyampaikan kembali dengan bahasa saya sendiri. Dengan ini, saya merasa lebih memahami materi dan dapat mempertahankan pendapat saya di hadapan guru dan teman kelas. Cara ini membantu memahami materi serta mempertahankan pendapat saat berdiskusi. Pembelajaran diskusi kelompok efektif karena melatih berpikir kritis, terutama pada sesi tanya jawab yang berlangsung aktif dan pemberian poin tambahan"* (I don't just look for answers on the internet, in books, or articles; I first study them thoroughly. I try to understand the context and then rephrase it in my own words. By doing this, I feel I better understand the material and can defend my opinions in front of teachers and classmates. This method helps in understanding the material as well as maintaining my opinions during discussions. Group discussion learning is effective because it trains critical thinking, especially during active question-and-answer sessions and when earning extra points). (Interview, November 7, 2025).



**Figure 2.** Question and Answer Session.

The conditions observed in the observation results are reinforced by the explanations from students and teachers during interviews, which indicate similar phenomena. This is supported by the expressions of Geomatics Engineering students:

*"Saya paling suka kerja kelompok pada sesi tanya jawab. Saat kelompok lain presentasi, kami diberi kesempatan bertanya tentang hal yang belum dipahami, lalu kelompok yang presentasi menjawab dan guru menegaskan kembali. Setiap pertanyaan diberi poin, sehingga suasana kelas menjadi aktif dan kompetitif. Pembatasan jumlah pertanyaan justru mendorong kami lebih bersemangat dan berpikir kritis sebelum bertanya"* (I like group work the most during the Q&A session. When another group was presenting, we were given the opportunity to ask questions about things we didn't understand, then the presenting group answered, and the teacher reinforced the explanation. Each question was awarded points, which made the classroom atmosphere active and competitive. Limiting the number of questions actually encouraged us to be more enthusiastic and think critically before asking). (Interview, November 12, 2025).

Revealing students of Welding Engineering and Metal Fabrication:

*"Guru mengingatkan agar saat presentasi kami tidak membaca teks atau menggunakan HP, tetapi benar-benar memahami materi yang disajikan. Kami diminta menjelaskan kasus, seperti pelanggaran HAM, dengan mendeskripsikan gambar dan memaparkannya di depan kelas. Cara ini menantang kami untuk berpikir mandiri, berani berbicara, dan tidak bergantung pada teknologi. Kami merasa strategi ini melatih kerja sama dan kesiapan menghadapi dunia kerja"* (The teacher reminded us that during the presentation, we should not read from the text or use our phones, but truly understand the material being presented. We were asked to explain cases, such as human rights violations, by describing images and presenting them in front of the class. This method challenged us to think independently, be brave to speak, and not rely on technology. We feel that this strategy trains teamwork and readiness to face the working world). (Interview, November 12, 2025).

The interview results indicate that a learning strategy emphasizing group discussions, presentations without reading texts or devices, and incentivized question-and-answer sessions effectively strengthen critical thinking among students at SMK Negeri 2 Surakarta. Restrictions on AI and phone usage encourage students to understand the material deeply, develop independent arguments, and confidently express their opinions. Teachers play an active role as concept enforcers and analysis guides, while AI use is limited to supporting clarification rather than serving as an instant answer source. This approach creates a participative, collaborative classroom that is relevant to job readiness in the era of artificial intelligence.

## **Discussion**

The initial findings of the study indicate that the development of critical thinking skills among vocational high school students in the AI era is achieved through the implementation of group discussions with strict limitations on AI usage. Through discussions, students are encouraged to seek credible sources, read and understand the material, and analyze information before formulating their own arguments. This strategy prevents students from relying on instant answers from AI, instead actively engaging in thinking, exchanging opinions, and justifying their ideas academically. As a result, group discussions become an effective means of fostering critical thinking and reading literacy. The research findings align with the results of other studies Priyono (2024) shows that group discussions can improve students' cognitive engagement and critical thinking skills by fostering dialogue and argumentation. This idea is also highlighted by Wardoyo et al (2025) which explains that collaborative learning at vocational high schools encourages a deeper understanding of concepts through group interaction and shared responsibilities. Conversely, Cholvistaria & Gunawan (2025) It explains that overreliance on artificial intelligence can weaken students' independence and critical thinking skills because they become dependent on quick answers. This view is supported by Gerlich (2025) which highlights that excessive use of AI can cause cognitive offloading and reduce reflective engagement. Additionally, Suhada et al (2025) emphasizes that case-based group discussions effectively promote critical awareness and digital ethics among vocational high school students, making restrictions on AI use during learning a relevant teaching strategy to boost critical thinking in the age of artificial intelligence.

Next, the second finding shows that the development of critical thinking skills among students at SMK Negeri 2 Surakarta is hindered by three main obstacles: excessive reliance on AI, low interest in reading and studying discipline, and differences in characteristics across majors that require different teaching strategies. Many students use AI and social media as sources of instant answers without engaging in reading and analysis, which weakens their reasoning abilities and leads them to rely on credible sources. Low reading interest also affects participation in discussions, encourages passive attitudes, and promotes answer copying without understanding the content. Meanwhile, teachers face pedagogical challenges because each major has different learning styles, making discussion approaches less consistently effective and requiring a mix of contextual and gradual strategies. Internal factors such as mood, learning preferences, and low academic responsibility further reinforce these barriers. These findings align with Talmaçchi (2025), who argues that excessive technology use can undermine deep reading skills and turn students into passive recipients of information. This is supported by Aura et al (2025), who found that reliance on instant answers undermines analytical skills, especially among students with low literacy. Additionally, Hidayat et al (2025) emphasize that without sufficient technological literacy, learning tends to be superficial and fails to promote critical thinking. This research finding also aligns with Mesin et al (2025), which demonstrates a positive relationship between digital literacy and critical thinking skills. From a pedagogical perspective, Nurkhalifah & Simanullang (2025) emphasize that teachers' challenges in implementing project- or *Problem-Based Learning* models lead to a shift back to lecture methods, resulting in students being less skilled at analyzing and evaluating information.

The third finding of the study shows that strengthening the critical thinking skills of SMK Negeri 2 Surakarta students in the AI era is carried out through project-based learning, enhancing reading literacy, and guiding responsible AI usage. Project-based learning encourages students to be directly involved in solving real-world problems related to their expertise, thereby training analysis, decision-making, and critical thinking skills that cannot be replaced by AI. Additionally, teachers implement limited rules on device and AI usage, encouraging students to understand the material, formulate arguments in their own words, and actively participate in discussions, presentations, and Q&A sessions. The teacher's role remains dominant as a guide and concept enhancer, while AI is positioned as a supporting tool for clarification, not as a source of instant answers, creating a collaborative, participatory, and relevant learning environment aligned with workforce readiness. These findings align with Putra et al (2025) which states that *Project-Based Learning* effectively enhances critical thinking through problem analysis and collaborative work, and is reinforced by Yusuf et al (2025) which emphasizes that real projects help students develop accountable solutions. In the context of vocational education, Martini et al (2024) showing that PjBL bridges theory and practice through the process of problem identification and the development of solutions relevant to the workplace. The restriction on AI use in learning also acts as an ethical safeguard to ensure that technology does not replace the reasoning process, as emphasized by Musa'ad et al (2024) read more Suhaedin (2024) emphasizes that *Project-Based Learning* can enhance logical thinking skills when students engage in contextual learning experiences. Conceptually, this finding aligns with the view that critical thinking develops through the process of interpreting, evaluating, and testing information independently, rather than accepting automatic answers without a thorough cognitive process

## Conclusion

Research at SMK Negeri 2 Surakarta yielded three main findings: (1) it shows that group discussions are effective in developing students' critical thinking skills in the AI era because they encourage students to read, understand, and analyze material before presenting arguments, thus not relying on instant answers from AI, while also strengthening reading literacy with limited use of AI as a clarification tool; (2) barriers to developing critical thinking arise from habits of instant learning, low reading interest, dependence on AI, and differences in characteristics and learning styles among majors, which demand diverse pedagogical strategies; and (3) strengthening critical thinking is achieved through project-based learning,

contextual practice, and ethical guidance in AI utilization so that technology functions as a support for the learning process rather than a substitute for students' reasoning. These findings indicate that developing critical thinking cannot rely solely on technology but requires a systematic and reflective pedagogical approach so that students can understand, evaluate, and construct arguments independently. This research provides practical implications that integrating discussion, projects, and reading literacy can enhance students' reasoning abilities in vocational schools and prepare them for a technology-based workforce, while also contributing theoretically to affirm AI's role as a supporter of the thinking process. The limitations of the study include its focus only on the context of critical thinking in the evolving AI era, its qualitative nature which may introduce bias, and its execution in only five majors out of ten, which may have different characteristics. Therefore, future research can be expanded through quantitative surveys, mixed methods, or more comprehensive cross-major comparisons to obtain a more complete picture of critical thinking reinforcement patterns in vocational education environments.

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